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Air Traffic Control Specialists in the Airway Science Curriculum Demonstration Project 1984-1990: Third Summative Report

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16. Abstract

The objective of this summative evaluation of the Airway Science Curriculum Demonstration Project (ASCDP) was to compare the performance, job attitudes, retention rates, and perceived supervisory potential of graduates from recognized Airway Science programs with those of individuals recruited through traditional means in the Air Traffic Control Specialist (ATCS) occupation. Previous evaluations conducted by the Higher Education and Advanced Technology Staff (1990) and the University Aviation Association (1990) described institutional and organizational benefits that accrued to the agency, participating institutions, and industry from the Airway Science program. In this technical evaluation, differences between Airway Science hires (N=312) and a random, stratified sample (N=312) of traditional ATCS hires on eight program objectives were evaluated: (1) interest in an aviation-related career; (2) attrition; (3) technical competence; (4) attitudes toward technological change; (5) managerial potential; (6) human relations skills; (7) female and minority representation; and (8) perceptions of the FAA. One one hand, controllers hired from the Airway Science register expressed significantly more interest in an aviation-related career (Objective 1) than controllers hired by traditional means. On the other hand, there were no significant differences between traditional hires and Airway Science hires on the remaining criteria. Overall, the performance of Airway Science hires was about the same as that of traditionally hired controllers. These results are consistent with other evaluations (Broach, 1990; Clough, 1988) conducted within the narrow framework defined by the Federal Register announcement of the demonstration project.

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AIR TRAFFIC CONTROL SPECIALISTS IN THE AIRWAY SCIENCE CURRICULUM DEMONSTRATION PROJECT 1984-1990: THIRD SUMMATIVE EVALUATION

INTRODUCTION

Purpose of Airway Science Curriculum Demonstration Project

The purpose of the Airway Science Curriculum Demonstration Project (ASCDP) was to compare the performance, job attitudes, and perceived supervisory potential of individuals recruited for 4 of the FAA's technical occupations who have an aviation-related, college-level education, or its equivalent, with individuals recruited for the same occupation through traditional methods (Office of Personnel Management (OPM), 1983a, 1983b). The ASCDP represented an alternative to the traditional hiring and recruitment strategy used by the FAA. This report presents a summative evaluation of the project as of the end of calendar year 1990.

Objectives of the Project

Evaluation research, such as described in this report, is concerned with securing evidence on the attainment of program objectives in terms of operationally defined criteria (Bloom, 1967; Rossi & Freeman, 1985). The *Federal Register* announcements of the ASCDP (OPM, 1983a, 1983b) specified 4 broad areas for evaluation. The first area focused on the recruitment and hiring of individuals who have completed, or have the equivalent of, the model curriculum. Data on the rates of application to, certification for, and hiring from the Airway Science registers have been previously reported (Broach, 1990). The results of that second summative evaluation indicated that hiring under the ASCDP consistently lagged behind both the goals set forth in the *Federal Register* announcements and the annually updated agency goals. Second, the concept that individuals with this Airway Science background were better able to perform the job than individuals recruited by existing methods was to be evaluated. The third evaluative topic identified by the *Federal Register* encompassed job performance, attitudes, and supervisory potential. Finally, the *Federal Register* required determination of the impact of the program "on the employment and career progression of women and minority candidates" (OPM, 1983, p. 11673).

Project Background

The inception, implementation, and revision of the ASCDP have been previously described in reports by Clough (1985, 1986a, 1986b, 1986c, 1987a, 1987b, 1988) and Broach (1990). The Airway Science Curriculum was proposed by former FAA Administrator J. Lynn Helms in 1981; the University Aviation Association (UAA), a professional organization for non-engineering collegiate aviation educators and institutions, provided assistance in refining the general academic concepts into a specific college curriculum. The FAA submitted a demonstration project evaluation plan to OPM in 1983, which was approved (OPM 1983a, 1983b). Originally planned as a 5-year demonstration program, OPM granted a 4-year extension to the demonstration project in 1987, when initial FAA hiring rates were well below projections (Broach, 1990). Rigidities in program requirements posed difficulties for participating institutions, as well, (Bowen, 1990) that were remedied by program revisions implemented in 1989 by the FAA and UAA. A summative evaluation was conducted jointly by the FAA Office of Training and Higher Education (AHT), the Civil Aeromedical Institute (CAMI), and the UAA in 1990 for the Office of the Secretary of Transportation. The qualitative evaluation by the Higher Education and Advanced Technology Staff (AHT-30; 1990) addressed program management, lessons learned, and recommendations. That report concluded that although the ASCDP had not fully met its stated objectives as of calendar year 1989, the identifiable, institutional and organizational benefits outweighed that apparent lack of success. The CAMI staff evaluation (Broach, 1990) provided quantitative data relative to program objectives within the evaluation framework stipulated by the *Federal Register* announcement of the demonstration project. That report concluded that the ASCDP had been less than successful in achieving its stated program objectives. The UAA evaluation (UAA, 1990) focused on the experience of the participating schools. The UAA analysis indicated that the ASCDP had been successful in providing entry-level technical and managerial employees to the broader aviation industry rather than the FAA. The UAA evaluation also noted positive effects on institutions of higher education stemming

from the ASCDP. Based on the AHT and UAA evaluations in particular, OPM agreed to terminate the ASCDP as a formal demonstration in 1990. At that point, Airway Science became an institutionalized permanent FAA program administered by the Office of Training and Higher Education (Director, Office of Training and Higher Education, 1990).

Evaluation Design

The evaluation design for the ASCDP was established in the 1983 *Federal Register* announcement. However, as noted by both Clough (1986a,b) and Broach (1990), the evaluation design confounded the influence of the specific curriculum on occupational success with the impact of an alternative selection strategy. The design required comparison of outcomes for the persons hired via the ASCDP registers with outcomes for a non-equivalent control group of persons hired via the "traditional" competitive OPM registers. The original research methodology assumed a clearcut distinction between Airway Science and traditional hires. However, the Airway Science rating guides provided for substitutions of relevant experience for formal education; as a result, persons hired via the special Airway Science registers included both graduates from approved Airway Science programs as well as non-college applicants that qualified by reason of experience and education. As a result, the research design confounded hiring strategy with the Airway Science curriculum. Such a confounded *ex post facto* design is essentially uninterpretable (Cook & Campbell, 1976). As a consequence, causal interpretations about the effects of the curriculum and hiring strategy cannot be made on the basis of evaluation results. However, the ASCDP can be qualitatively assessed in relation to the broad program objectives defined for the project. This third summative evaluation, therefore, focuses on the degree to which the ASCDP achieved its agency-related program objectives.

METHOD

Sample

Population characteristics

Overall. Data on a total (N) of 10,277 cases from 3 technical occupations were available from the Airway Science data base: (a) air traffic control specialists; (b) electronics technicians; and (c) aviation safety inspectors. The population mean age at the time of hire was 27 (SD = 5, N = 10,228), and ranged from 18 to 58 years of age. Of the 10,229 cases indicating gender, 15.8% (N = 1,623) were female. Minorities accounted for 9.1% (N = 939) of the 10,141 cases providing ethnic group identification data. Non-veterans represented 88.2% (N = 9,065) of the 10,185 cases for which veteran's preference information was available. The modal educational level for 10,226 cases was the equivalent of 1 or 2 years of post-secondary education (43.4%, or N = 4,463), either in technical/ trade schools or formal academic institutions. Just 0.2% (N = 18) had not completed high school or obtained an equivalency diploma; some 20.3% (N = 2,085) had completed high school or its equivalent. Some 7.7% of the population (N = 793) had completed 3 or 4 years of college. Just 1.4% (N = 148) had completed a post-baccalaureate degree. A total of 26.5% (N = 2,719) had completed a bachelor's degree.

By occupation. Air traffic control specialists (ATCS) represented 94.3% (N = 9,693) of the population in the Airway Science data base. Hires from the Air Traffic Airway Science register represented only 3.2% (N = 312) of the controllers. There were only 47 graduates from recognized schools with degrees in an approved area of concentration among the controllers hired between 1984 and 1990. Electronic technicians (ET) represented a mere 2.2% (N = 228) of that population; aviation safety inspectors (ASI) accounted for 3.4% (N = 355) of the cases in the Airway Science data base. Hires from the ET Airway Science register accounted for 48.9% (N = 112) of technician new hires. There were no graduates from recognized schools with degrees in an approved area of concentration in this sample of technicians hired between 1984 and 1990. Hires from the ASI Airway Science register represented 12.4% (N = 44) of the inspectors hired between 1984 and 1990; just 6 of these Airway Science hires were graduates of recognized colleges with a degree in an approved area of concentration. Demographic characteristics of the ASCDP population are presented by occupation in Table 1.

Evaluation sample

Because controllers constituted the bulk of the ASCDP population and accounted for most of the hiring under the terms of the ASCDP, this evaluation focused on the experience of the

Table 1

Demographic Characteristics of Population by Occupation

Characteristic	Category	ATCS	ET	ASI
Age	*M*	26.4	34.4	42.4
	SD	3.4	8.3	7.8
Sex	*Male*	83.2% (8,062)	89.5% (205)	95.5% (339)
	Female	16.4% (1,590)	7.4% (17)	4.5% (16)
	Missing	0.4% (41)	3.1% (7)	
Race	*Nonminority*	89.7% (8,696)	80.3% (184)	90.7% (322)
	Minority	9.0% (875)	14.8% (34)	8.5% (30)
	Missing	1.3% (122)	4.8% (11)	0.8% (3)
Veteran	*Non-veteran*	91.8% (8,901)	41.5% (95)	19.4% (69)
	Veteran	7.6% (735)	50.2% (115)	76.1% (270)
	Missing	0.6% (57)	8.3% (19)	4.5% (16)
Education	*LT High school*	0.2% (18)		
	High school	20.4% (1,977)	16.2% (37)	20.0% (71)
	2-year college	43.3% (4,196)	58.5% (134)	37.5% (133)
	3-4 yrs college	7.8% (759)	4.4% (10)	6.8% (24)
	Bachelor degree	26.6% (2,581)	15.7% (36)	28.7% (102)
	Postgraduate	1.2% (119)	2.2% (5)	6.8% (24)
	Missing	0.4% (43)	3.1% (7)	0.3% (1)
Airway Science Education	*None*	96.8% (9,379)	51.1% (117)	88.9% (311)
	Experience only	0.3% (28)	7.4% (17)	1.7% (6)
	Non-avtn major	0.5% (51)	16.2% (37)	3.1% (11)
	Aviation major	0.4% (39)	0.9% (2)	0.8% (3)
	Avtn graduate	1.5% (147)	0.9% (2)	3.7% (13)
	Airway Science	0.5% (47)		1.7% (6)
	Missing	0.0% (2)	23.6% (54)	1.4% (4)

Note: Number in category shown in parentheses to right of percentages

ATCS occupation in the demonstration project. Their experience as an occupational group can be considered representative of the success or failure of the ASCDP. Terminal and En Route controllers only were included in the evaluation sample; Flight Service Specialists (FSS) were excluded because of the fundamental differences in the jobs performed. The unequal group sizes between traditional hires and Airway Science hires in the ATCS occupation indicated a requirement for sampling the traditional hire population. The traditional ATCS hires were stratified by education; random samples were taken from each stratum such that a number equal to Airway Science hires with the same educational level in an occupation were selected for the analysis. The demographic characteristics of the evaluation sample of controllers are presented in Table 2. Traditionally-hired controllers were slightly older, on the average ($M = 26.3$, $SD = 2.9$ years), than controllers hired via the Airway Science register ($M = 25.9$, $SD = 3.0$; $t(1,310) = 6.71$, $p \leq .05$). However, the representation of women in the 2 groups was not significantly different (18.6% of traditional versus 13.8% of Airway Science hires, $Z = -1.63$, $p > .05$). While slightly more minority specialists were represented in the Airway Science group (10.3%), the percentage was not significantly different from their representation in

the stratified sample of traditionally-hired controllers (6.1%, $Z = 1.92$, $p > .05$). Nor were the percentages of veterans in the 2 groups (5.7% versus 7.7%) significantly different ($Z = -1.00$, $p > .05$). Finally, given that the sampling frame was stratified on education, there was no significant difference in the proportions of undergraduate college graduates (59.9% versus 58.7%) between the 2 samples ($Z = -0.31$, $p > .05$).

Table 2

Demographic Characteristics of Evaluation Sample

Characteristic	Category	Traditional ($N = 312$)	Airway Science ($N = 312$)
Age	*M*	26.3	25.9
	SD	2.9	3.0
Sex	*Male*	81.4% (254)	73.1% (228)
	Female	18.6% (58)	13.8% (43)
	Missing		13.1% (41)
Race	*Nonminority*	92.9% (290)	74.0% (231)
	Minority	6.1% (19)	10.3% (32)
	Missing	1.0% (3)	15.7% (49)
Veteran	*Non-veteran*	94.2% (294)	92.3% (250)
	Veteran	5.7% (18)	7.7% (21)
	Missing		13.1% (41)
Education	*HS Diploma*	9.6% (30)	6.4% (20)
	2-year college	19.9% (62)	13.1% (41)
	3-4 yrs college	6.7% (21)	6.1% (19)
	Bachelor degree	59.9% (187)	58.7% (183)
	Postgraduate	3.8% (12)	2.6% (8)
	Missing		13.1% (41)

Data Collection Instruments and Procedures

General framework

Operational criteria defined by Clough (1988) and Broach (1990) for this evaluation are presented in Table 3. Data collection to support the evaluation focused on (a) identifying new hires, with careful attention to the identification of true Airway Science graduates entering via the traditional OPM registers, (b) extracting and matching required data from relevant computerized data bases, and (c) collecting attitudinal, training progress, and performance appraisal data in annual surveys. Computerized data sources utilized in the course of the evaluation include the FAA Consolidated Personnel Management Information System (CPMIS) and the CAMI ATCS Selection data base. Instruments to collect attitudinal, training, and performance data were designed by CAMI researchers (Clough, 1987a, 1988). Selected data from the supporting data bases and from various ASCDP surveys were consolidated into a single ASCDP data base, as described by Broach (1990). Participation in the project was a condition of employment for Airway Science hires. In contrast, the participation of the traditionally-hired subjects was voluntary. The participation of traditional air traffic hires was solicited at the time of entry onto duty with the agency at the FAA Academy. Survey instruments were mailed annually to participants and their supervisors, based on the enter-on-duty (EOD) date. Various indices and scales were constructed to operationally represent the criteria for evaluating attainment of the project objectives. The focus of this evaluation was on

individual outcomes within the ATCS occupation, such as remaining with the FAA and technical competence, rather than on institutional outcomes, such as ties between the FAA and academia.

Table 3

Project Objectives and Evaluation Criteria

Project Objectives	Evaluation Criteria
Objective 2A To assess the unique impact of a tailor-made curriculum on one's interest in pursuing an aviation-related career.	Aviation-related education completed (semester hours) Aviation-related work experience, licenses, and certificates Rated importance of aviation-related career
Objective 2B To assess the unique impact of a tailor-made curriculum on occupational and organizational attrition.	Occupational attrition Organizational attrition
Objective 3 To improve the technical competence of the FAA workforce.	Occupational training performance Formal performance appraisal results
Objective 4 To develop within the FAA an increased acceptance of technological change.	Effect of automation on job perceptions Perceived changes in job from automation
Objective 5 To recruit individuals with managerial potential.	Managerial potential as rated by supervisor
Objective 6 To attract individuals with greater awareness of and skills in maintaining positive human relations.	Interpersonal skills as rated by supervisor
Objective 7 To increase female and minority representation.	Proportions female/minorities retained
Objective 8 To improve employee perceptions of the FAA.	Degree that FAA meets employee work needs Job satisfaction

RESULTS

Interest in Aviation-Related Career

Amount of aviation-related education

As might be expected, Airway Science hires completed significantly more aviation-related credit hours in degree-oriented programs than members of the traditional hire control group. Specifically, 66.8% of the Airway Science controllers reported completing 30 or more credit hours, while 79.1% of the control group reported completing less than 6 aviation-related credit hours ($\chi^2(4) = 228.9, p \leq .001$).

Degree of aviation-related work experience

Degree of aviation-related work experience was represented by 2 variables: (a) actual aviation work experiences reported by subjects; and (b) the number of aviation certificates or licenses held by an individual. Just 7.7% of the Airway Science hires reported 6 or more aviation-related work experiences such as employment as a pilot, flight instructor, or mechanic; 40.1% of the 312 Airway Science hires reported no aviation-related work experience prior to employment by the FAA. In comparison, just 2.6% of the control group reported 6 or more aviation-related work experiences, while 44.2% indicated no prior aviation employment before joining the agency. However, while the overall distribution of responses was significantly different from a chance distribution ($\chi^2(3) = 10.0$, $p \leq .05$), the only statistically significant difference in rates was for those controllers indicating having held 6 or more aviation-related jobs. A significantly greater percentage of controllers hired from the Airway Science register (7.7%) reported having held 6 or more aviation jobs than traditionally-hired specialists (2.6%; $Z = 2.88, p \leq .01$).

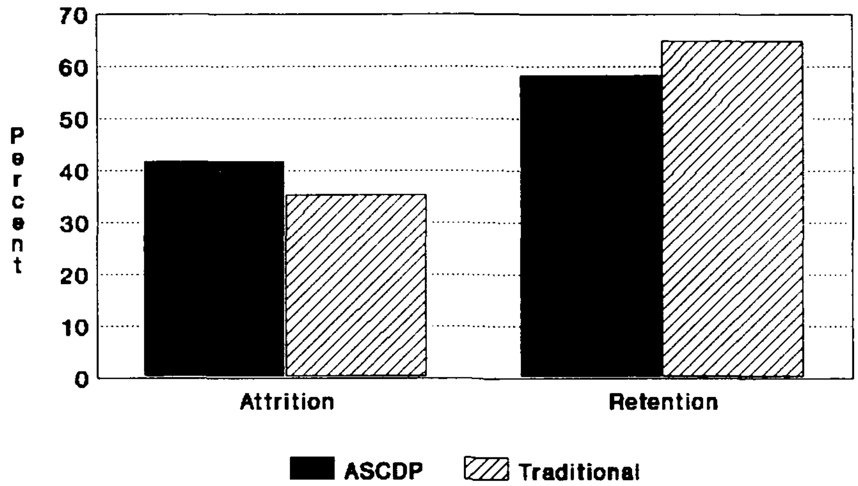
Career importance

Controllers from both groups were asked to rate the importance of a career in aviation on a 5-point, Likert-type scale with the following anchors: 1 = *Not at all important*; 2 = *Of limited importance*; 3 = *Of moderate importance*; 4 = *Of considerable importance*; 5 = *Of very great importance*. As described by Broach (1990), these data were collected at 3 points in time: after 1 year of employment; after 2 years; and 3 years after entering on duty with the FAA. Airway Science hires rated the importance of a career in aviation as more important ($M = 4.73$) after 1 year of employment than traditionally-hired controllers ($M = 4.45$, $F(1,170) = 7.74$, $p \leq .01$). However, due to lower response rates in the second and third years of data collection, as described by Broach (1990), those apparent differences disappeared. After 2 years of employment, for example, the rated importance of a career in aviation for traditionally-hired controllers ($M = 4.61$) was not statistically different from the rating given by Airway Science controllers ($M = 4.58$; $F(1,35) = .02$, $p > .05$). A similar pattern after 3 years of employment was observed ($M_{Traditional} = 4.71$ vs. $M_{ASCDP} = 4.54$, $F(1,16) = 0.32$, $p > .05$). Overall, a career in aviation appeared to be more important to controllers hired from the Airway Science register than for specialists hired from the traditional competitive register in the first year of employment only. However, the small sample sizes and resulting lack of statistical power do not support reliable inferences about the relative importance of an aviation career in subsequent years of employment.

Attrition

For purposes of this evaluation organizational attrition was defined as "retention in any occupation or loss for any reason of the controller by the FAA;" that is, a controller separated or resigning from the agency was an organizational loss. Occupational attrition was defined as "separation from the ATCS occupational field series (GS-2152) but remaining in the FAA's employ." Overall, the rates of organizational attrition for controllers in the 2 comparison groups from 1984 to 1990 were not significantly different (Figure 1). The rate of attrition among the Airway Science hires was 41.7%, while that in the sample of traditionally-hired controllers was 35.3% ($Z = 1.64$, $p > .05$). On one hand, the organizational loss rate for Airway Science controllers was no different than the loss rate for traditionally-hired specialists. On the other hand, the rate of occupational attrition among the Airway Science controllers was 7.0%, compared to a rate of just 3.2% in the sample of traditionally-hired specialists ($Z = 2.16$, $p \leq .01$). Overall, it appears that the net loss rate from the controller occupation was higher among the Airway Science hires than in the stratified sample of traditionally-hired air traffic control specialists.

Figure 1
Organizational attrition and retention rates by comparison groups



Technical Competence

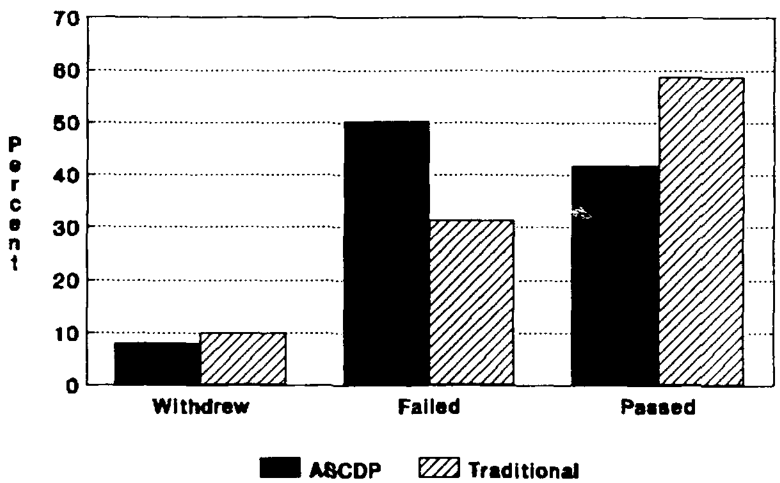
Occupational training

The critical point in the occupational training of controllers is the FAA Academy ATCS Screen (FAA Academy course 50321). The ATCS Screen is the second stage of a multiple hurdle selection system; the first stage consists of the OPM written ATCS aptitude test battery. The ATCS Screen is a 9-week program administered in 3 phases. First, newly hired controllers receive 4 weeks of classroom, academic instruction on nonradar air traffic control rules and principles. There are 4 multiple-choice, written examinations corresponding to the blocks of instruction provided in the academic phase of the ATCS Screen. ATCS Screen students are also required to draw the map of the synthetic training air space from memory. These block test and map scores are combined into an overall academic block average (NLBA). A comprehensive phase test (NLCPT) is administered at the end of the academic phase of instruction. The block average counts as 8% of the student's final composite score in the Screen; the comprehensive phase test accounts for 12% of that final grade. The second major phase of the Screen focuses on hands-on application of those rules and principles in laboratory simulation scenarios. This laboratory phase requires approximately 5 weeks. There are a total of 6 graded laboratory problems; the best 5 scores are used to compute a student's final grade in the ATCS Screen (AVL5). The grade on each laboratory scenario is composed of a technical score and an instructor assessment of the student's potential, equally weighted. Laboratory scores account for 60% of the student's composite final score in the Academy program. The final phase of the Screen program consists of a timed, written multiple-choice examination. This Controller Skills Test (NLCST) accounts for 20% of the final, composite ATCS Screen score (NLCOMP) earned by the student at the FAA Academy. A

minimum final score of 70 is required to pass the ATCS Screen; students earning less than 70 fail the course. The majority of failing students are terminated from employment with the FAA.

Two analyses were conducted for this evaluation. First, the pass and fail rates of the 2 groups were compared. The pass rate in the ATCS Screen for controllers selected from the Airway Science register (41.7%) was significantly lower than the pass rate for the sample of controllers hired by traditional means (58.7%; $Z = -4.25$, $p \leq .01$). As might be expected, the failure rate for Airway Science hires (50.3%) was higher than that of traditional hires (31.4%; $Z = 5.15$, $p \leq .01$). The withdrawal rates for the 2 groups (8.0% versus 9.9% for traditional hires) were not statistically different ($Z = -0.12$, $p > .05$). These pass, fail, and withdrawal rates for each group are presented in Figure 2. Second, the Screen component and final composite scores were submitted to a 1-way analysis of variance (ANOVA) by group (Airway Science versus traditional hires). The results of that analysis are presented in Table 4. The academic scores (NLBA and NLCPT) for the controllers hired from the Airway Science register were statistically lower than the scores for the stratified, random sample of traditionally-hired controllers. The performance of Airway Science hires was also significantly lower in the graded laboratory scenarios than for the traditionally-hired specialists. That same pattern was repeated on the Controller Skills Test. And as might be expected in view of the pass rate differences, the mean composite final scores for controllers hired under the ASCDP ($M = 57.2$) was significantly less than the mean composite final scores ($M = 70.7$) for the stratified sample of controllers hired from the traditional competitive register.

Figure 2
ATCS Screen outcomes by comparison group



General performance appraisals

The FAA general performance appraisal system is designed to describe specific employee strengths and weaknesses relative to pre-established written performance standards. Supervisors are required tu review an employee's position description and identify critical job elements. Each critical job element is weighted with regard to its contribution or importance to

the position. Specific standards for "outstanding," "exceptional," "fully successful," "partially successful," and "unacceptable" performance on those critical job elements are defined by the supervisor. The employee's performance is appraised relative to those specific standards in the course of the evaluation. Those ratings for each critical job element are then weighted; the weighted scores are then summed to create an overall composite rating. A composite score of 2.7 to 3.0, with no critical job element rated at less than exceptional, earns an "outstanding" rating. An "exceptional" rating requires a composite score of 1.0 to 2.69, with no job element rated at less than fully successful. A score of 0 to .99, with no critical job element rated at less than partially successful, receives a "partially successful" rating.

The employee's most recent composite, categorized rating was extracted from the CPMIS for this analysis. Scores for 121 Airway Science hires and 172 traditional hires were obtained from CPMIS. These composite scores were submitted to a 1-way ANOVA by comparison group. The average general performance appraisal composite score for Airway Science controllers was 2.20. The mean performance rating score for the sample of traditionally-hired specialists was 2.08. No critical job element for either group received a less than "fully acceptable" rating. The differences between means were statistically significant ($F(1,291) = 5.88, p \leq .05$). Airway Science hires appear to earn higher ratings on general performance appraisals than traditionally-hired controllers.

Table 4

Results of 1-Way ANOVA of ATCS Screen Scores by Comparison Group

Measure	Group	*N*	*M*	*Min-Max*	*SD*	*F*
NLBA	ASCDP	304	78.6	0.0 - 100.0	34.3	28.8***
	Traditional	293	90.6	0.0 - 100.0	17.7	
NLCPT	ASCDP	304	75.2	0.0 - 100.0	33.1	28.1***
	Traditional	293	86.8	0.0 - 100.0	17.9	
AVL5	ASCDP	286	51.1	0.0 - 92.6	27.4	42.7***
	Traditional	279	63.8	0.0 - 95.5	17.4	
NLCST	ASCDP	286	58.3	0.0 - 98.0	30.3	56.4***
	Traditional	279	74.4	0.0 - 96.0	19.4	
NLCOMP	ASCDP	286	57.2	0.0 - 94.4	28.5	47.0***
	Traditional	279	70.7	0.0 - 91.4	16.7	

***$p \leq .001$

Acceptance of Technological Change

The fifth objective of the ASCDP was the development of an increased acceptance of technological change within the FAA's critical occupations. The FAA Capital Investment Plan is the FAA's comprehensive program for modernizing and improving the National Airspace System. The plan objectives are to meet current and future demands for air traffic services, reduce errors and aviation hazards, make better use of personnel and equipment, and create a foundation for future improvements. A critical piece of this plan is the Advanced Automation System, a consolidated network of high-speed, high-efficiency computers and advanced controller workstations. Controllers will use sophisticated computer graphics, decision aiding software, and procedures to manage complex traffic. Controller acceptance of the changes in the job brought about by this increased automation is important to the organizational and technological success of the Advanced Automation System.

Therefore, Clough (1987a) developed 5 items for the annual Status Survey to assess attitudes toward automation. As reported by Broach (1990), 2 scales were derived from the 5 items through factor analysis. The "Automation Effects" scale, based on 3 items, assessed the degree to which respondents perceived that their effectiveness, job satisfaction, and challenge experienced in the job, would change with increased automation. Scale values were as follows: 1 = *Definitely negative effect*; 2 = *Probably negative effect*; 3 = *Neutral or no effect*; 4 = *Probably positive effect*; 5 = *Definitely positive effect*. The "Automation Changes" scale, derived from 2 survey items, assessed the degree that automation had changed or was expected to change the job itself in the respondent's view. Scale values were: 1 = *No change*; 2 = *Little change*; 3 = *Some change*; 4 = *Much change*; 5 = *Extensive change*. These ratings were submitted to 1-way ANOVA by comparison group for each year of the Status Survey, as presented in Table 5.

Controllers hired from the Airway Science register completing the first status survey (Year 1; N = 74) indicated that automation would probably have a positive effect on their job effectiveness, satisfaction, and degree of challenge experienced (M = 3.76). As shown in Table 8, specialists hired by the traditional process who completed the first status survey (N =98) also indicated that automation would probably have a positive effect on their job effectiveness, satisfaction, and experienced degree of challenge (M = 3.49). Airway Science hires were more positive than traditional hires in this perception ($F(1,170) = 5.67$, $p \leq .05$). However, the practical importance of a 1/4-point difference in mean ratings must be considered, given that as sample sizes increase, smaller and smaller differences become

Table 5

Acceptance of Technological Change by Comparison Group

Year	Group	*N*	*M*	*Min-Max*	*SD*	*F*
			Perceived Effect of Automation on Job			
1	ASCDP	74	3.76	2 - 5	0.72	5.67*
	Traditional	98	3.49	1 - 5	0.74	
2	ASCDP	19	3.68	2 - 5	0.89	0.68
	Traditional	18	3.89	3 - 5	0.58	
3	ASCDP	7	3.00	3 - 5	0.82	3.56
	Traditional	11	3.73	2 - 4	0.79	
			Perceived Change in the Job Due to Automation			
1	ASCDP	98	2.76	1 - 5	0.83	1.14
	Traditional	76	2.92	2 - 5	0.96	
2	ASCDP	18	3.17	2 - 5	1.20	2.49
	Traditional	19	3.74	1 - 5	0.99	
3	ASCDP	7	3.43	2 - 5	1.13	0.18
	Traditional	11	3.64	2 - 5	0.92	

* $p \leq .05$

"statistically significant." The mean Automation Effects rating (M = 3.68) for the 19 Airway Science controllers that completed the second status survey (year 2) was not statistically different from the rating given by 18 traditional hires (M = 3.89; $F(1,35) = 0.68$, $p > .05$). Similarly, the mean Automation Effects rating for just 11 Airway Science controllers completing the third Status Survey (Year 3; M = 3.72) was not statistically different from that given by just 7 traditional hires (M = 3.00; $F(1,16) = 3.56$, $p > .05$). Overall, it appears that there were no practical differences between the 2 groups in their perceptions of the effects of automation on their job effectiveness, satisfaction, and degree of challenge experienced in the job.

A similar pattern in the perceptions of changes in the job due to automation was observed between groups. Controllers hired from the Airway Science register responding to the first status survey (Year 1; N = 74) perceive or expect some degree of change in their jobs due to automation (M = 2.76). Specialists hired from the traditional registers completing the first status survey (N = 98) also perceive or expect that some change in their job due to automation (M = 2.92). The difference in means was not statistically significant ($F(1,172) = 1.14$, $p > .05$). The mean Automation Changes ratings for the 18 Airway Science hires completing the second status survey (Year 2; M = 3.17) was not statistically different from the rating given by the 19 traditional hires in their second status survey (M = 3.74; $F(1,35) = 2.49$, $p > .05$). As presented in Table 6, there were no differences in mean ratings of Automation Changes by group for those controllers who completed the third annual status survey. Both groups in the third survey indicated expecting or perceiving "much" change in their jobs due to automation. The increase across years in the degree of change expected or perceived as a consequence of automation might be explained by increasing awareness of the FAA Advanced Automation System as the controllers move through training, coincident with increased publicity for and attention to that automation system. Overall, however, the controllers hired from the Airway Science registers appeared about as receptive to automation as specialists hired from the traditional registers.

Managerial Potential

The sixth objective of the ASCDP was to recruit individuals with managerial potential. Clough (1987a) designed the 5-item "Index of Managerial Potential" (IMP) to assess the degree to which participants demonstrated skills linked to effective management. Supervisors of participating employees completed the IMP once a year. Analyses of the IMP by Broach (1990) indicated that a single dimension captured 70% of the variance across IMP dimensions. Therefore, IMP scales were collapsed within a year of data collection to create an overall, summary index of managerial potential for

Table 6

Managerial Potential by Comparison Group

Year	Group	*N*	*M*	*Min - Max*	*SD*	*F*
1	ASCDP	90	3.39	2 - 5	0.77	0.14
	Traditional	140	3.43	1 - 5	0.80	
2	ASCDP	14	3.57	2 - 5	0.76	4.81*
	Traditional	17	2.94	1 - 5	0.83	
3	ASCDP	3	3.33	3 - 4	0.58	0.50
	Traditional	3	2.67	1 - 4	1.53	

* $p \leq .05$

analysis. These single-scale scores for each year were submitted to one-way ANOVA by comparison group; the results of the analysis are presented in Table 6.

Managerial potential was indexed on the following scale: 1 = *Definitely does not have potential*; 2 = *Probably does not have potential*; 3 = *Uncertain about potential*; 4 = *Probably has potential*; and 5 = *Definitely has potential*. There were no significant differences between groups after 1 year of employment in perceived managerial potential (ASCDP $M = 3.39$; Traditional $M = 3.43$, $F(1,228) = 0.14$, *ns*). However, these results might be explained by considering that field supervisors had relatively little exposure to the new employee after 1 year of employment, as a large proportion of that employee's time was spent at the FAA Academy and in facility classrooms with little direct interaction with the supervisor. Comments received from field supervisors suggested that they felt uncomfortable trying to assess a new employee's managerial potential. However, supervisors rated the managerial potential of Airway Science hires after 2 years of employment more highly ($M = 3.57$) than that of traditional hires ($M = 2.94$; $F(1,29) = 4.81$, $p \leq .05$). The number of supervisors completing the assessment of employee managerial potential after 3 years of employment was too small to support meaningful statistical analysis. The data suggest that there might be differences in the perceived managerial potential of the 2 groups; however, the low rates of return in the second and third years of data collection preclude valid conclusions from being drawn from the data.

Human Relations Skills

The seventh objective of the ASCDP was to attract individuals with greater awareness of and skills in maintaining positive human relations. This objective was operationally represented by Clough (1987a) as a single facet within the Index of Managerial Potential. Supervisors of the participants in the demonstration project rated each person on their "interpersonal skills" each year. Supervisors responded to the question, "How would you describe this individual's interpersonal skills" on the following 5-point, Likert-type scale: 1 = *Poor*; 2 = *Somewhat below average*; 3 = *Average*; 4 = *Somewhat above average*; 5 = *Excellent*. These ratings of interpersonal skills after 1 year (Year 1), 2 years (Year 2), and 3 years (Year 3) of employment were submitted to 1-way ANOVA by comparison group. The results of that analysis are presented in Table 7.

Table 7

Rated Human Relations Skills by Comparison Group

Year	Group	*N*	*M*	*Min - Max*	*SD*	*F*
1	ASCDP	90	3.49	2 - 5	0.81	0.25
	Traditional	139	3.55	1 - 5	0.89	
2	ASCDP	14	3.29	2 - 4	0.61	1.22
	Traditional	17	3.00	1 - 5	0.79	
3	ASCDP	3	4.00	2 - 4	0.00	4.00
	Traditional	3	3.33	1 - 4	0.58	

* $p \leq .05$

There were no differences in the rated human relations or interpersonal skills between the Airway Science hires ($M = 3.49$) and controllers hired by traditional means ($M = 3.55$, $F(1,227) = 0.25$, $p > .05$) after 1 year of employment. Nor were there any significant differences between groups after 2 or 3 years of employment, although the small sample sizes preclude reliable statistical inferences. Overall, the data show that the perceived human relations

skills of controllers hired from the Airway Science register were not different from that of specialists hired via traditional means.

Female and Minority Representation

The next objective of the ASCDP was to increase the representation of women and minorities within the FAA technical occupations. This objective was operationally represented as the relative rates of organizational entry and attrition for women and minorities. Organizational attrition was defined as having left the service of the FAA as of the end of calendar year 1990, as reflected in CPMIS nature-of-action codes. Consider first, new hires entering onto duty with the agency from each group. The percentage of minority new hires in the control group (6.1%) was not significantly different from that of minority new hires in the Airway Science group (10.3%, $Z = 1.91$, $p > .05$). The percentage of women in the control group sample (18.6%) entering the agency's employ was not significantly different from that for the Airway Science group (13.8%; $Z = -1.63$, $p > .05$). The attrition and retention rates for the comparison samples of controllers are presented by minority status and sex of participant in Table 8. First, the retention rates for minority and majority participants within each sample (e.g., ASCDP hires) were not statistically different (minority v. majority Airway Science, $Z = 0.78$, $p > .05$; minority v. majority Traditional hires, $Z = 0.32$, $p > .05$). Second, the organizational retention rate of minority Airway Science hires was not significantly different from that of minority Traditional hires ($Z = 0.64$, $p > .05$). Third, the retention rates for men and women within each comparison sample (e.g., Traditional hires) were not significantly different. For

Table 8

Organizational Retention Rates by Comparison Group, Sex, and Minority Status

Group	Sample	Attrited	Retained
	By Minority Status of Participant		
Minority	ASCDP	13 (40.6%)	19 (59.4%)
	Traditional	6 (46.2%)	13 (53.8%)
Majority	ASCDP	111 (48.1%)	120 (51.9%)
	Traditional	102 (35.2%)	188 (64.8%)
	By Sex of Participant		
Female	ASCDP	22 (51.2%)	21 (48.8%)
	Traditional	24 (41.4%)	34 (58.6%)
Male	ASCDP	108 (47.4%)	120 (52.6%)
	Traditional	86 (33.9%)	168 (66.1%)

example, 48.8% of the women hired from the Airway Science register were retained by the FAA, while 52.6% of the men hired from thatregister remained with the agency ($Z = 0.45$, $p > .05$). Similarly, the retention rate of 58.6% for traditionally-hired women hired was not significantly less than that of traditionally-hired men (66.1%; $Z = -1.09$, $p > .05$). Finally, the retention rate for women hired from the Airway Science register (48.8%) was not significantly less than the rate for women hired via the traditional registers (58.6%; $Z = -0.98$, $p > .05$).

FAA Employee Perceptions

Employee perceptions of the FAA, reflected in measures of job satisfaction, continue to be an

Table 9

Facet Job Satisfaction by Comparison Group

Year	Group	*N*	*M*	*Min - Max*	*SD*	*F*
			Personal Satisfaction with Job			
1	ASCDP	76	4.08	1 - 5	0.73	2.09
	Traditional	98	3.94	1 - 5	0.55	
2	ASCDP	19	4.00	2 - 5	0.75	0.94
	Traditional	18	3.78	2 - 5	0.65	
3	ASCDP	11	4.00	2 - 5	0.77	1.63
	Traditional	7	3.57	3 - 4	0.53	
			Satisfaction with Co-workers			
1	ASCDP	76	3.80	1 - 5	0.78	0.09
	Traditional	98	3.84	2 - 5	0.68	
2	ASCDP	19	3.84	1 - 5	1.01	0.05
	Traditional	18	3.78	2 - 5	0.65	
3	ASCDP	11	3.27	1 - 4	1.01	0.12
	Traditional	7	3.43	2 - 4	0.79	
			Satisfaction with Supervisor			
1	ASCDP	76	3.78	1 - 5	0.81	0.88
	Traditional	98	3.66	1 - 5	0.77	
2	ASCDP	19	3.84	1 - 5	1.07	0.86
	Traditional	18	3.56	2 - 5	0.78	
3	ASCDP	11	2.73	1 - 4	1.19	2.12
	Traditional	7	3.43	3 - 4	0.53	

(Table 9 continues)

(Table 9 continued)

Year	Group	*N*	*M*	*Min - Max*	*SD*	*F*
			Satisfaction with Degree of Autonomy			
1	ASCDP	76	3.14	2 - 5	0.69	2.09
	Traditional	98	2.99	2 - 5	0.71	
2	ASCDP	19	3.16	2 - 5	0.76	0.39
	Traditional	18	3.00	2 - 5	0.77	
3	ASCDP	11	3.27	2 - 4	0.65	0.62
	Traditional	7	2.71	2 - 4	1.11	
			Satisfaction with Pay			
1	ASCDP	76	3.42	1 - 5	0.96	0.82
	Traditional	98	3.55	1 - 5	0.92	
2	ASCDP	14	3.14	1 - 5	1.03	0.01
	Traditional	11	3.18	1 - 5	0.87	
3	ASCDP	11	2.82	1 - 5	1.60	0.02
	Traditional	7	2.71	1 - 4	1.11	
			Satisfaction with Performance Evaluation/Appraisal System			
1	ASCDP	76	3.07	1 - 5	0.77	0.44
	Traditional	98	2.99	1 - 4	0.74	
2	ASCDP	19	2.89	1 - 4	0.88	0.33
	Traditional	18	2.72	1 - 4	0.96	
3	ASCDP	11	2.55	1 - 3	0.69	0.01
	Traditional	7	2.57	2 - 3	0.53	

issue of organizational importance, as reflected in the biennial FAA job satisfaction surveys (Myers, Schroeder, Van Deventer, & Collins, 1988; Schroeder, Collins, & Dollar, 1984; Schroeder, Thomas, Weltin, Van Deventer, Collins, Dollar, & Ritchie, 1986). Twenty-six items, developed in collaboration with OPM researchers, were incorporated into the annual status surveys to assess various facets of job satisfaction. Broach (1990) used factor analysis to identify 6 underlying dimensions: (a) personal satisfaction; (b) satisfaction with co-workers; (c) satisfaction with supervisors; (d) satisfaction with degree of autonomy afforded the participant; (e) satisfaction with pay; and (f) satisfaction with the performance evaluation/appraisal process. Facet job satisfaction was indexed on the following 5-point, Likert-type scale: 1 = *Very dissatisfied*; 2 = *Dissatisfied*; 3 = *Neutral*; 4 = *Satisfied*; and 5 = *Very satisfied*. Scores on each facet were submitted to 1-way ANOVA by comparison group for each year. The results of that analysis are presented in Table 9.

The personal satisfaction facet included items assessing overall personal satisfaction with the job, performing meaningful work, general satisfaction, and how much the employee liked working for the FAA. As presented in Table 9, there were no significant differences between Airway Science controllers and traditionally-

Table 10

Summary Evaluation of ASCDP Relative to Program Objectives

Project Objective	Evaluation Criteria	Outcome
Objective 2A To assess the unique impact of a tailor-made curriculum on one's interest in pursuing an aviation-related career.	Aviation-related education completed	+
	Aviation-related work experience, etc.	+
	Rated importance of aviation-related career	+
Objective 2B To assess the unique impact of a tailor-made curriculum on occupational and organizational attrition	Occupational attrition	-
	Organizational attrition	0
Objective 3 To improve the technical competence of the FAA workforce	Occupational training performance	-
	Formal performance appraisal results	+
Objective 4 To develop within the FAA an increased acceptance of technological change	Effect of automation on job perceptions	0
	Perceived changes in job from automation	0
Objective 5 To recruit individuals with managerial potential	Rated managerial potential	0
Objective 6 To attract individuals with greater awareness of and skills in maintaining positive human relations	Rated interpersonal skills	0
Objective 7 To increase female and minority representation	Proportions of females/minorities retained	0
Objective 8 To improve employee perceptions of the FAA	Degree that FAA meets employee work needs	0
	Job satisfaction	0

Notes: Following symbols are used in the "Outcome" column: - = ASCDP lower than traditional hires; 0 = No difference between groups; + = ASCDP higher than traditional hires on criteria

hired controllers in the degree of personal job satisfaction after 1, 2, or 3 years of employment. Generally, participating employees were "Satisfied." However, as before, the data for the second and third year must be interpreted cautiously due to the low rate of return of surveys. The facet scale assessing employee satisfaction with co-workers was derived from 4 items (Broach, 1990). A sample item is, "*My group works well together.*" There were no significant differences between groups in the degree to which they were satisfied with their co-workers. Both Airway Science and traditionally-hired controllers were "Satisfied" with their co-workers. Satisfaction with one's supervisor was the third facet scale evaluated in this study, also based on 4 items from the annual Status Survey. "*My supervisor helps me solve work-related problems*" is an example item from this facet. As with the previous facets of job satisfaction, there were no significant differences between Airway Science and traditionally-hired controllers in the degree of their satisfaction with their supervisors after 1, 2, or 3 years of employment. Overall, both groups were "Satisfied" with their supervisors.

The next job satisfaction facet to be analyzed was employee satisfaction with the degree of autonomy offered in the job of air traffic control specialist. An example from this set of 5 items is, "*I have control over how I spend my time working.*" As presented in Table 9, the same pattern as before was found, with no significant differences between groups across years of employment. While both groups had been "Satisfied" on the preceding facet scales, controllers appeared to be neither satisfied nor dissatisfied regarding the degree of autonomy experienced on the job. Satisfaction with pay was assessed by 2 items. An example item is, "*Considering my skills and the effort I put into my work, I am satisfied with my pay.*" There were no significant differences between groups. The controllers appeared to be neutral, though there appeared to be a trend across the years toward greater dissatisfaction with pay. The final job satisfaction facet scale was derived from 3 items reflecting satisfaction with the performance evaluation/appraisal system. A sample item is, "*My performance rating represents a fair and accurate picture of my actual performance.*" As with pay satisfaction, there were no significant differences between groups within each year of employment, with the groups being neither satisfied nor dissatisfied. However, the ratings for this job satisfaction appeared to be somewhat lower, overall, than for other facets of the job. Overall, the job satisfaction of controllers hired from the Airway Science register appeared to be indistinguishable from that of controllers hired via traditional registers.

CONCLUSIONS

The pattern of evaluation results is summarized in Table 10. Airway Science hires appeared to have more interest in pursuing an aviation-related career, as evidenced by the amount of aviation education completed, aviation work experience reported, and rated importance of a career in aviation. The occupational attrition rate for airway Science hires was greater than the attrition rate for traditionally hired controllers; overall organizational loss rates were the same for the two groups. Airway Science hires performed as well as traditional hired in initial occupational training, but received higher formal performance ratings on the job. There were no differences between the groups with respect to attitudes toward automation, rated managerial potential, interpersonal skills, minority and female retention rates, and job satisfaction. Overall, the data presented in this summative evaluation indicate that the cadre of individuals produced by the demonstration project's hiring strategy are indistinguishable from more traditionally hired persons. The fundamental design of this evaluation, however, precludes a casusal interpretation of effects, or conversely, lack of enhancing effects, from the Airway Science curriculum.

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